Amendment to Claims

Claims 1 and 3-6 have been amended to more particularly point out and distinctly claim the subject matter of the invention. The amendments find support in the specification. No new matter has been introduced as a result of these amendments. The changes from the previous version to the rewritten version are shown in attached Appendix A, with strikethroughs for deleted matter and underlines for added matter.

Claims 1-9 are pending following entry of the present amendment.

Claim Objections

The Examiner has objected to claims 1 and 3-6 because the language "as well as Mn" is alleged to be confusing because the language could be interpreted to mean Mn is part of the listing. In response, Applicant has amended claims 1 and 3-6 so they use conventional Markush language. In claim 1, Mn is indeed part of the recited Markush group. The inclusion of Mn in the recited Markush group finds support in the specification. In addition, claims 3-6 are consistent with the inclusion of Mn in the recited Markush group in claim 1.

Applicant respectfully submits that the claims as written clearly and correctly define the members of each recited Markush group. No new matter has been introduced as a result of these amendments. The amendments find support in the specification. Thus, Applicant respectfully requests entry of amended claims 1 and 3-6.

Rejection under 35 U.S.C. § 112, second paragraph

The Examiner has rejected claims 1-9 under 35 U.S.C. § 112, second paragraph, because it is said that the presence of the term "type" in the phrase "spin-valve type" renders the phrase indefinite. The term "spin-valve type" is widely used in the art. In fact, a brief survey of references relating to magnetoresistive sensors reveal articles that use the term "spin-valve type" or "spin valve type." The specification also provides examples of conventional spin-valve type magnetoresistive sensors (see Figs. 13 and

14, for example). However, to obviate the objection under 35 U.S.C. § 112, second paragraph, Applicant has amended claims 1-9 so that each claim now recites a "spin-valve magnetoresistive sensor" instead of a "spin-valve type magnetoresistive sensor." Applicant submits that this amendment to each of claims 1-9 does not narrow their scope compared to those of the previously filed claims. Applicant also maintains that the use of the term "spin-valve type" in the original claims is proper and acceptable.

The Examiner has also rejected claim 1 under 35 U.S.C. § 112, second paragraph, as being incomplete for omitting the relative location of the electrically conductive layers. In response, Applicant has amended claim 1 such that it now recites the relative location of the electrically conductive layers. This amendment finds support in the specification.

Based on the above, Applicant respectfully requests withdrawal of the rejection of claims 1-9 under 35 U.S.C. § 112, second paragraph, and entry of the amended claims.

Rejection under 35 U.S.C. § 102(e)

The Examiner has rejected claims 1, 7, and 8 under 35 U.S.C. § 102(e) as being anticipated by U.S. Patent No. 6,074,767 ("Lin").

The Examiner asserts that Lin discloses "<u>soft magnetic layers (elements 41)</u> arranged on said free magnetic layer" (emphasis added) and "bias layers (elements AFM_2) formed on said soft magnetic layers."

In fact, in Lin, <u>element 41</u> combines with a second antiferromagnetic layer to form bias layers. See column 6, lines 34-38. Thus, according to the Examiner, the bias layers are <u>formed from</u> soft magnetic layers and antiferromagnetic layers. In contrast, claim 1 of the present invention recites bias layers that are <u>formed on</u> soft magnetic layers, rather than recite bias layers that comprise soft magnetic layers and a second antiferromagnetic layer.

Thus, Lin cannot anticipate claim 1 of the present invention. Since claims 7 and 8 both depend from claim 1, Lin also cannot anticipate claims 7 and 8 of the present invention. Applicant therefore respectfully requests that the Examiner withdraw the rejection of claims 1 and 7-8 under 35 U.S.C. § 102(e).

Rejection under 35 U.S.C. § 103(a)

The Examiner has rejected claims 3 and 4 under 35 U.S.C. § 103(a) as being unpatentable over Lin. According to the Examiner, it would have been obvious to one of ordinary skill in the art to modify the device of Lin by using the Mn-X alloys of the claimed invention.

The Examiner has also rejected claims 2 and 9 under 35 U.S.C. § 103(a) as being unpatentable over Lin in view of U.S. Patent No. 6,201,673 ("Rottmayer"). The Examiner asserts that it would have obvious to one of ordinary skill in the art to modify the device of Lin by using a synthetic free magnetic layer as recited in claims 2 and 9.

The Examiner has also rejected claims 5 and 6 under 35 U.S.C. § 103(a) as being unpatentable over Lin in view of Rottmayer, Applicant's disclosure, and U.S. Patent No. 6,007,643 ("Kishi"). According to the Examiner, it would have been obvious to one of ordinary skill in the art to modify the device of Lin in view of Rottmayer and Applicant's disclosure by using a PtMn-X antiferromagnetic composition as taught by Kishi to form antiferromagnetic layers possessing superior corrosion resistance.

In response, Applicant respectfully submits that Lin or its combination with any of the above references cannot render any of the claims 1-9 obvious. Since claims 2-9 all depend from claim 1, Applicant's arguments below will focus on demonstrating why all of the above-cited references, either individually or in combination, cannot render claim 1, and hence claims 2-9, obvious.

To establish a *prima facie* case of obviousness, the combined references must disclose every limitation of a claim. The Examiner has not provided any evidence that

Lin, even when combined with any of the above cited references discloses, teaches, or suggests every limitation of claims 1-9.

Claims 2-9 of the present invention all depend from claim 1. However, claim 1 recites bias layers that are formed on soft magnetic layers, rather than recite bias layers that are formed from soft magnetic layers and a second antiferromagnetic layer. Lin, for one, has not been shown by the Examiner to disclose or teach this particular feature of the present invention. In addition, Lin requires at least two antiferromagnetic layers, one for exchange-coupling with a reference layer and another for exchange coupling with a ferromagnetic film.

Second, the combined references must provide motivation to one of ordinary skill in the art to modify the teachings of the references to arrive at the claimed invention. The Examiner has not shown that a combination of the above-cited references would motivate one of ordinary skill in the art modify the teachings of the combined references to arrive at a spin-valve type magnetoresistive sensor that comprises bias layers that are formed on soft magnetic layers and that uniformly arrange a magnetization direction of a free magnetic layer in a direction crossing the magnetization direction of a pinned magnetic layer.

Third, even if the combined references teach or suggest every limitation of a claim, the combined references must imbue one of ordinary skill in the art with a reasonable expectation of success. The Examiner has not provided evidence that this criterion has also been met by Lin or its combination with any of the above-cited references. As mentioned above, Lin requires at least two antiferromagnetic layers, one for exchange-coupling with a reference layer and another for exchange coupling with a ferromagnetic film. Lin also teaches bias layers that comprise a second antiferromagnetic film and a ferromagnetic layer.

On the other hand, claim 1 of the present invention recites a pinned magnetic layer formed in contact with an antiferromagnetic layer and having a magnetization

direction made stationary under an exchange anisotropic magnetic field generated by interaction with said antiferromagnetic layer. Claim 1 recites bias layers that are <u>formed on</u> soft magnetic layers, rather than recite bias layers that are <u>formed from</u> soft magnetic layers and a second antiferromagnetic layer. In addition, claim 1 does not recite a second antiferromagnetic layer for exchange-coupling with a reference layer. The Examiner has not shown that Lin, even when combined with any of the above-cited references, would have taught or suggested these features of the claimed invention.

Nothing in Lin, even when combined with any of the above-cited references, would have suggested that one can modify the magnetoresistive sensor of Lin (or a magnetoresistive sensor that the other cited references disclose or teach) to arrive at the present invention. Even assuming that Lin would have suggested the claimed invention, the Examiner has not provided any evidence that Lin, or its combination with any of the above-cited references, would have imbued one of ordinary skill in the art with a reasonable expectation of success in modifying Lin's teachings to arrive at the claimed invention. In particular, the Examiner has not shown that Lin's teachings, or those of its combination with the other references, would have allowed one of ordinary skill in the art to obtain the advantages provided by the claimed invention.

The claimed invention provides several advantages. For example, the soft magnetic layer formed between the free magnetic layer and the bias layer allows the magnetization direction of the free magnetic layer to be arranged uniformly with certainty. Also, the present invention discloses that by forming a soft magnetic layer of the same material as that of the free magnetic layer, ferromagnetic coupling would be more likely occur at the interface between the soft magnetic layer and the free magnetic layer. As a result, a unidirectional and anisotropic exchange-coupled magnetic field produced at the interface between the bias layer and the soft magnetic layer can be transmitted to the free magnetic layer through the soft magnetic layer.

Another advantage provided by the present invention is that the ferromagnetic coupling at the interface between the free magnetic layer and the soft magnetic layer is

not as sensitive to contamination as the exchange coupling at the interface between a free magnetic layer and an antiferromagnetic layer. Thus, a sufficient level of a longitudinal magnetic field can be certainly imparted to the free magnetic layer even when the soft magnetic layer is formed after breaking vacuum and exposing the laminate to the atmosphere. Moreover, in the present invention, the surface of the laminate may be cleaned using techniques such as ion milling or reverse sputtering before forming the soft magnetic layer, without breaking vacuum.

The Examiner has also rejected claims 1-4 and 7-9 under 35 U.S.C. § 103(a) as being unpatentable over Rottmayer in view of Applicant's disclosure. The Examiner alleges that since Rottmayer discloses the use of a synthetic free magnetic layer recited in claims 2 and 9, the Mn-X alloys recited in claims 3 and 4, the NiFe recited in claim 7, and the etching of the capping layer until the free ferromagnetic layer is exposed as recited in claim 8, Rottmayer renders claims 1-4 and 7-9 obvious.

The Examiner has also rejected claims 5 and 6 under 35 U.S.C. § 103(a) as being unpatentable over Rottmayer in view of Applicant's disclosure and Kishi. The Examiner asserts that it would have been obvious to one of ordinary skill in the art to use a PtMn-X antiferromagnetic composition as taught by Kishi to form antiferromagnetic layers possessing superior corrosion resistance.

In particular, the Examiner asserts that Applicant teaches that "the non-magnetic spacer layer is an electrically conductive material inorder [sic] for the MR head to function (col. [sic] 5, lines 10-15). In fact, the paragraph in the specification that was cited by the Examiner merely states that a non-magnetic electrically conductive layer and the other recited components are formed in a particular order in an example of a bottom type single-spin-valve magnetoresistive sensor. Nowhere in that passage does it say, or suggest, that a non-magnetic spacer layer has to be made of an electrically conductive material for the MR head to function. There might be benefits accruing to the use in a bottom type single-spin-valve of a non-magnetic spacer layer that is

electrically conductive, but that is certainly not equivalent to saying that the non-magnetic spacer layer has to be electrically conductive for a MR head to function.

Because the Examiner's assertion regarding the necessity of using an electrically conductive spacer for the MR head to properly function was based on a misreading of Applicant's disclosure, this assertion is invalid.

The Examiner also contends that claim 8 would have been obvious because Rottmayer teaches ion milling the capping layer until the free magnetic layer is exposed, and etching inherently removes some of the free magnetic layer and thus produces a recess before the soft magnetic layer deposition.

Recesses, no matter how minute, may inevitably form during etching, but Rottmayer does not suggest that the free magnetic layer should be etched to intentionally form recesses on the free magnetic layer. In fact, what Rottmayer teaches is that "[t]he etching <u>preferably stops just after the top ferromagnetic layer **126**, **126'**, or **126"** is exposed</u>." (Emphasis added.) Indeed, Rottmayer suggests that forming a recess in the ferromagnetic layer is undesirable. Rottmayer therefore teaches away from the present invention.

In contrast, the present invention discloses that recesses in the free magnetic layer provide several benefits. For example, the present invention discloses that forming recesses in the magnetic layer can effectively remove contaminants on the free magnetic layer surface. In addition, the recesses in the free magnetic layer can further enhance the ferromagnetic exchange coupling between the free magnetic layer and the soft magnetic layer. Further, without recesses, dead areas may arise on both ends of a track which can lead or contribute to degradation of sensor sensitivity. Especially in view of Rottmayer's teaching above, these results are unexpected and contribute to the present invention's being unobvious over the cited art.

Because Rottmayer does not disclose, teach, or suggest these advantages—but in fact teaches away from this particular feature of the invention— it is an impermissible use of hindsight to assert that the presence of a recess in a free magnetic layer, when combined with Rottmayer's teaching, would have rendered the claimed invention obvious. Moreover, Rottmayer, even when combined with an asserted inherent presence of a recess in a free magnetic layer, provides neither a motivation nor a reasonable expectation of success to one of ordinary skill in the art. Thus, Rottmayer does not and cannot cure any deficiency underlying a mere presumption that a recess inherently exists in a free magnetic layer.

Finally, differences per se between a claimed invention and the teachings of the combined references are not required to be unobvious. It is the claimed subject matter as a whole that must be considered in establishing a *prima facie* case of obviousness. Thus, the obviousness of a claimed invention cannot be predicated solely on the individual differences (or similarities) between a claimed subject matter and the teachings of the combined references.

As amended, claim 1 recites, for example, soft magnetic layers that are arranged on said free magnetic layer having a spacing corresponding to a track width between said soft magnetic layers and that fill recesses in the free magnetic layer on both sides of an area corresponding to the track width. For the various reasons already discussed above, neither Lin, Rottmayer, either individually or in combination with each other or other references, teach or suggest the claimed invention. Thus, they do not render claim 1, and hence all of claims 2-9 which depend from claim 1, obvious.

Applicant therefore respectfully requests that the rejection of the claims under 35 U.S.C. § 103(a) be withdrawn.

Conclusion

Applicant submits that this application is now in condition for allowance, and favorable reconsideration of this application in view of the above amendments and remarks is respectfully requested. Allowance of claims 1-9 at an early date is earnestly solicited.

Respectfully submitted,

Gustavo Siller, Jr.
Registration No. 32,305
Attorney for Applicant

BRINKS HOFER GILSON & LIONE
P.O. BOX 10395
CHICAGO, ILLINOIS 60610
(312) 321-4200

APPENDIX A

Version With Markings To Show Changes Made

Attorney Docket No. 9281/3660

Serial No. 09/586,624

Please amend claims 1-9 as follows:

1. (Twice Amended) A spin-valve ~~type~~ magnetoresistive sensor comprising, on a substrate, an antiferromagnetic layer; a pinned magnetic layer formed in contact with said antiferromagnetic layer and having a magnetization direction made stationary under an exchange anisotropic magnetic field generated by interaction with said antiferromagnetic layer; a non-magnetic electrically conductive layer formed between a free magnetic layer and said pinned magnetic layer; soft magnetic layers that are arranged on said free magnetic layer having a spacing corresponding to a track width between said soft magnetic layers and that fill recesses in the free magnetic layer on both sides of an area corresponding to the track width ; bias layers formed on said soft magnetic layers ~~and~~ to uniformly arrange a magnetization direction of said free magnetic layer in a direction crossing the magnetization direction of said pinned magnetic layer; and electrically conductive layers formed on the bias layers to apply a detection electric current to said free magnetic layer,

said antiferromagnetic layer and said bias layer each comprising an alloy containing at least one element selected from a group consisting of ~~among~~ Pt, Pd, Rh, Ru, Ir, Os, Au, Ag, Cr, Ni, Ne, Ar, Xe, ~~and~~ Kr, ~~as well as~~ and Mn.

2. (Twice Amended) A spin-valve ~~type~~ magnetoresistive sensor according to Claim 1, wherein at least one of said pinned magnetic layer and said free magnetic layer is divided into two layers with a non-magnetic intermediate layer interposed between the two layers, and the divided two layers are held in a ferrimagnetic state in which the divided two layers are magnetized in directions 180° different from each other.

3. (Twice Amended) A spin-valve ~~type~~ magnetoresistive sensor according to Claim 1, wherein said antiferromagnetic layer comprises an alloy having the following composition formula;

X_mMn_{100-m}

where X is at least one element selected from a group consisting of ~~among~~ Pt, Pd, Rh, Ru, Ir and Os, and a composition ratio *m* satisfies 48 atom % $\leq$ m $\leq$ 60 atom %.

4. (Twice Amended) A spin-valve ~~type~~ magnetoresistive sensor according to Claim 1, wherein said bias layer comprises an alloy having the following composition formula;

X_mMn_{100-m}

where X is at least one element selected from a group consisting of ~~among~~ Pt, Pd, Rh, Ru, Ir and Os, and a composition ratio *m* satisfies 48 atom % $\leq$ m $\leq$ 60 atom %.

5. (Twice Amended) A spin-valve ~~type~~ magnetoresistive sensor according to Claim 1, wherein said antiferromagnetic layer comprises an alloy having the following composition formula;

$Pt_mMn_{100-m-n}D_n$

where D is at least one element selected from a group consisting of ~~among~~ Pd, Rh, Ru, Ir and Os, and composition ratios *m, n* satisfy 48 atom % $\leq$ m + n $\leq$ 60 atom % and 0.2 atom % $\leq$ n $\leq$ 40 atom %.

6. (Twice Amended) A spin-valve ~~type~~ magnetoresistive sensor according to Claim 1, wherein said bias layer comprises an alloy having the following composition formula;

$Pt_mMn_{100-m-n}D_n$

where D is at least one element selected from a group consisting of ~~among~~ Pd, Rh, Ru, Ir and Os, and composition ratios *m, n* satisfy 52 atom % $\leq$ m + n $\leq$ 60 atom % and 0.2 atom % $\leq$ n $\leq$ 40 atom %.

7. (Twice Amended) A spin-valve ~~type~~ magnetoresistive sensor according to Claim 1, wherein said soft magnetic layer is made of a NiFe alloy.

8. (Twice Amended) A spin-valve ~~type~~ magnetoresistive sensor according to Claim 1, wherein recesses are formed in said free magnetic layer on both sides of an area corresponding to a track width, said soft magnetic layers are formed to fill said recesses and are directly joined to said free magnetic layer through bottom surfaces of said recesses, and said bias layers and said electrically conductive layers are successively formed on said soft magnetic layers.

9. (Twice Amended) A spin-valve ~~type~~ magnetoresistive sensor according to Claim 1, wherein said free magnetic layer is divided into a first free magnetic layer disposed farther away from the pinned magnetic layer and a second free magnetic layer disposed closer to the pinned magnetic layer, a non-magnetic intermediate layer is interposed between the first free magnetic layer and the second free magnetic layer, a magnetic film thickness of said first free magnetic layer is smaller than a magnetic film thickness of said second free magnetic layer.